REMARKS

A marked-up version of the rewritten claims is attached hereto.

Claim 10 has been amended as requested. It is therefore submitted that it now conforms to 35 U.S.C 112, 1st paragraph.

Claim 1 has been amended to recite "a system". It is therefore submitted that claims 1-11 now conform to 35 U.S.C. 112, 2nd paragraph.

A disclaiming declaring from the co-authors of the Mao et al. reference who are not co-inventors of the present application is enclosed. Since the present application was filed within one year of the publication date of Mao, it is no longer a valid reference. Thus it is requested that the rejection of claims 1 and 8-11 under 35 U.S.C. 102 on Mao be withdrawn.

The present invention discloses a method of growing semiconductor expitaxial layers on a substrate in which the supersaturation of the growth solution and the composition of the layers is controlled by varying the pressure rather than the temperature. As the control of pressure is a developed technique, and the pressure can be changed rapidly and accurately, this means that supersaturation can be controlled more easily. Furthermore, the phase diagram of the solid layer ingredients as a function of pressure is monotonous and quasi-linear, while as a function of temperature it is complicated and non-monotonous. This means that it is easier to control the solid layer ingredients when using the method of the invention. The method also allows graded layers to be grown, and makes

iterative growth processes easier, resulting in better quality epitaxial layers and great flexibility in the growth process.

Nishizawa discloses a vapor pressure controlled temperature difference method to control conductivity type and concentration with silicon dopant in GaAs. Arsenic vapor is supplied onto the surface of the growth solution which consists of a Group III melt, the required amount of silicon and a source crystal. As the GaAs vapor pressure is increased, the conductivity type of the growth film is changed from p-type to n-type. An extra heater is placed over the growth solution in order that the source crystal is at a higher temperature than the epigrowth wafer. When the epigrowth wafer is brought into contact with the growth solution, the Ga and As atoms in the melt move from regions of high temperature to regions of low temperature to recrystallize onto the epigrowth wafer.

The Examiner is claiming that this document discloses the growth of epitaxial layers at a constant temperature, and varying the vapor pressure to give varying composition of the layer. However, the growth of a layer by this method is determined by the temperature difference between the epigrowth crystal and the source crystal on the melt solution (col. 3, line 65, to col. 4, line 19). Therefore, there will be no epitaxial growth if there is no temperature difference and the temperature remains constant with time. Furthermore, it is disclosed in col. 4, at line as 11 to 19, that the vapor pressure does not affect the growth rate.

This is in contrast to the present invention in which the pressure inside the growth chamber is varied to directly affect the degrees of supersaturation so that epigrowth occurs on the

growth substrate. The temperature can be kept constant during the growth process when the melt is in contact with the growth substrate. It is respectfully submitted that it is incorrect to equate the vapor pressure of As in Nishizawa's method with the pressure inside the growth chamber of the present invention (which is used to control the degree of supersaturation). In part (iii) of claim 1 of the present invention, it is recited that the pressure of the system is varied in order to change the supersaturation of the growth solution, and this feature is not disclosed in Nishizawa.

Nishizawa's method will not work for other types of III-V compounds such as InP or GaSb-based materials, unlike the present invention, which is suitable for all III-V compounds. Furthermore, the material composition of the Nishizawa layers will not be affected by the As vapor pressure variation. This is in contrast to the present invention which enables control of the layer's composition through pressure variation.

Therefore the rejection of claims 1 and 8-10 under 35 U.S.C. 102 on Nishizawa should be withdrawn.

Bauser discloses a method of utilizing centrifugal force from the rotation of the growth chamber to transport liquid solution to the growth wafer and also to control local supersaturation of the solution at the growth surface. The wafer is mounted so that the resultant forces from the centrifugal force and gravity are perpendicular to the growth surface. A supply of the material to be deposited can be mounted opposite the growth wafer in order that supply material is continuously dissolved into the growth solution and transported to the growth wafer surface by the centrifugal force.

It is respectfully submitted that the Examiner is incorrect in interpreting the centrifugal force used in Bauser as being equivalent to the pressure in the present invention. The degree of supersaturation in Bauser depends not directly on pressure arising from the centrifugal force, but on the rotation speed and atomic mass difference among the different elements in the growth solution. Therefore, unlike the method of the present invention, supersaturation is not controlled by the pressure. There is no flexibility in determining the material composition of the layers grown as the respective concentration gradients masses. The centrifugal force separates out the elements in the growth solution according to their atomic masses, forming a concentration gradient of the elements in the growth solution.

Furthermore, as the centrifugal force in Bauser is used to bring the growth solution into contract with the substrate (as well as to form a concentration gradient), the material composition of the upper-most surface of growth substrate will be different from that of the lower part of the epilayer on the growth substrate. This is because the centrifugal force cannot be reduced to zero instantaneously when growth of the layer is ceased.

The method described by Bauser results in pressure from the centrifugal force that is higher than atmospheric pressure. It is not possible to achieve pressure lower than atmospheric pressure using the centrifugal system. Hence, the centrifugal force-based pressure change to the growth solution in Bauser is limited, and is not equivalent to the pressure variation described in the present invention.

Therefore the rejection of claims 1 and 9 under 35 U.SS.C. 102 on Bauser should be withdrawn.

Bernardi is concerned with mercury and cadmium materials, and with the very specific problem of the evaporation of mercury when making layers. In particular, this document is directed towards the epitaxial growth of HgCdTe. The solution to the problem of mercury evaporation provided by Bernardi is to both prepare the growth solution and carry out the epitaxial growth in a single phase (col. 2, lines 40 to 47). This document is therefore concerned with a different problem to that of the present invention, in which growing semiconductor epitaxial layers in which it is easy to control supersaturation and the composition of the layers is disclosed (page 2, lines 23 to 38). The method of the present invention can be applied to any III-V compound semiconductor wafer.

As the Examiner acknowledges, Bernardi does not disclose varying pressure to bring the growth solution to supersaturation. Bernardi refers several times to varying the temperature to control the concentration of Hg in the growth solution and therefore points towards conventional methods of epitaxial layer growth.

The disclosure of Bernardi is similar to the disclosure of the two documents described in the description on page 2, at lines 15 to 23. These two documents are also concerned with the growth of HgCdTe layers.

Dugger discloses a method of growing single crystals of aluminum nitride using calcium nitride as a solvent. Aluminum nitride is melted into the calcium nitride solvent and the temperature then

lowered to induce supersaturation and the precipitation of aluminum nitride crystals. Although this document discloses that the degree of supersaturation in a solution can be changed by changing the pressure of the solution, it actually varies the supersaturation by changing the temperature. This document therefore points away from varying the pressure and instead reinforces the user of temperature variation. Dugger does not suggest the benefits (such as ease of control of layer ingredients and growth of graded layers) obtained when using the method of the present invention (see page 3, line 17, to page 4, line 9, of the present application).

Also, Dugger is concerned with the growth of three-dimensional bulk single crystals rather than two-dimensional thin films on top of a substrate as with the present invention. The skilled man would not look to Dugger when seeking to address the problems solved by the present invention as it does not address the same problem. Even if the skilled man were to look at Dugger, this document contains only a passing comment that changing the pressure can affect the degree of supersaturation. There are no details of the physical effects involved, the pressure is not varied in any of the examples and the document does not teach that varying the pressure would have any advantages when growing epitaxial layers.

Furthermore, this document is in a different technical field to Bernardi. The skilled man would therefore not think to combine Bernardi and Dugger as they are concerned with such different problems. Even if the skilled man were to combine these documents, the combination discloses only a vague reference to varying the pressure with no example of this being used. No

advantages of using a method in which the pressure is varied are disclosed.

Therefore the rejection of claims 1-2, 5 and 9 under 35 U.S.C. 103 on Bernardi in view of Dugger should be withdrawn.

Cook discloses a method of utilizing a gas bubble to separate two growth solutions, and moving this bubble to transport the desired growth solution to the growth substrate. This "bubble-mode LPE" allows for multiple layer growth through the movement of different growth solutions driven by the gas bubble. Any gas pressure introduced serves only to move the bubble to transport the desired growth solution onto the growth substrate. This document does not teach that the pressure can be used to control the supersaturation of the growth solution, and nor does it disclose the benefits of doing so according to the invention.

Therefore the rejection of claims 3-4 & 6-7 on 35 U.S.C. 103 on Bernardi in view of Dugger and Cook should be withdrawn.

Hsieh is concerned with the growth of thin III-V layers using a super cooling method. This document discloses a method involving allowing a growth solution to reach thermal equilibrium, lowering its temperature to bring the solution to a supercooled state, and then contacting the solution with the substrate. This conventional supercooling technique is discussed in the application on page 1 at lines 27 to 32. Hsieh does not disclose varying the pressure, as the Examiner acknowledges in paragraph 13. It is instead concerned with controlled the temperature and supercooling.

Hsieh and Dugger are concerned with different technical areas, and therefore the skilled man would not think to combine the teaching of these two documents. Hsieh is concerned with the growth of thin III-V layers using supercooling, whereas Dugger is concerned with growing three-dimensional aluminum nitride crystals. Even if the skilled man were to combine these two documents, there is only a passing reference to varying the pressure in Dugger, and nowhere do these two documents suggest the advantages obtained when varying the pressure according to the method of the invention.

Therefore, the rejection of claims 10-11 on 35 U.S.C. 103 on Bernardi in view of Dugger and further in view of Hsieh should be withdrawn.

For similar reasons the rejection of claims 1 and 8-11 under 35 U.S.C. 103 on Hsieh in view of Dugger should be withdrawn.

Similarly, the rejection of claims 2 and 5 under 35 U.S.C. 103 over Hsieh in view of Dugger and further in view of Bernardi should be withdrawn.

Also, the rejection of claims 3-11 under 35 U.S.C. 103 over Hsieh in view of Dugger, Bernardi and further in view of Cook should be withdrawn.

For all of the foregoing reasons, it is respectfully submitted that all of the claims now present in the application are clearly novel and patentable over the prior art of record, and are in proper form for allowance. Accordingly, favorable reconsideration and allowance is respectfully requested. Should

any unresolved issues remain, the Examiner is invited to call Applicants' attorney at the telephone number indicated below.

A check in the amount of $400.00 is enclosed for a two month extension of time. The Commissioner is hereby authorized to charge payment for any fees associated with this communication or credit any over payment to Deposit Account No. 16-1350.

Respectfully submitted,

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Date: 12/20/02

Signature: Denise Spaulding
Person Making Deposit

Application No.: 009/894,186

Marked Up Claim(s)

1. (Amended) A method of growing semiconductor expitaxial layers on a substrate comprising the steps of:

providing a system which includes a substrate,

providing at least a first growth solution and optionally one or more further growth solutions, and

(i) exposing the substrate to the first growth solution, the growth solution being under a supersaturated condition such that a first layer grows on the surface of the substrate; and,

(ii) optionally exposing the substrate to one or more further growth solutions, the further growth solutions being under a supersaturated condition such that one or more further layers grow on the surface of the first layer; and

(iii) varying the pressure of the system to change the degree of supersaturation of the first growth solution or one or more further growth solutions to affect the growth of the first layer or one or more further layers.

10. (Amended) A method according to claim 1 wherein said semiconductor epitaxial layers comprise a system which includes [III-IV] III-V epitaxial layers.